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● *Original Contribution*

POCKET-SIZE IMAGING DEVICES ALLOW FOR RELIABLE BEDSIDE SCREENING FOR FEMORAL ARTERY ACCESS SITE COMPLICATIONS

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Abstract—The aim of this study was to validate pocket-size imaging devices (PSIDs) as a fast screening tool for detecting complications after femoral artery puncture. Forty patients undergoing femoral artery puncture for arterial access related to percutaneous coronary intervention were enrolled. Twenty-four hours after percutaneous coronary intervention, the involved inguinal region was assessed with PSIDs enabling 2-D gray-scale and color Doppler imaging. Subsequently, examination with a stationary high-end ultrasound system was performed to verify the findings of bedside examination in all patients. In 37 patients, PSID imaging had good diagnostic quality. False aneurysms (one asymptomatic) occurred in four patients, and all were recognized during bedside screening with PSID. One case of femoral artery thrombosis was confirmed with PSID and during standard ultrasonographic examination. Physical examination augmented with the quick bedside PSID examination had a sensitivity of 100% and specificity of 91%. PSID facilitated rapid bedside detection of serious access site complications in the vast majority of patients, including asymptomatic cases. (E-mail: dominika.filipiak@gmail.com) © **2014 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Pocket-size imaging devices, Femoral artery puncture, Pseudo-aneurysm.**

INTRODUCTION

Percutaneous procedures are a mainstay of modern diagnostics and therapy in cardiology. Although the radial approach is being increasingly adopted, femoral access still remains in wide use for angiography and angioplasty (Wang et al. 2012). Despite their significant positive influence on symptomatic status and prognosis in patients with ischemic heart disease, these invasive procedures carry a notable risk of complications. The most common adverse outcomes are vascular access site complications, such as pseudo-aneurysms, arteriovenous fistulas and femoral artery thromboses (Kalarus et al. 2012; Stone and Campbell 2012). The incidence of pseudo-aneurysms, which represent more than two-thirds of all access site complications, is estimated at 1.2% by physical examination. However, when puncture sites are assessed by means of ultrasonography, the local complication rate increases to 7.7% (Ates et al. 2006, Morgan and Belli 2003), emphasizing the role of ultrasonography in establishing an early diagnosis. Many studies suggest that low-risk patients undergoing percutaneous coronary intervention (PCI) procedures might be confidently discharged on the same day (Antonsen and Jensen 2013). However, such an approach requires rapid, thorough assessment of the patient's condition, with the focus on post-procedural complications, including access site status. Early screening of each patient undergoing a percutaneous intravenous procedure with the use of high-end stationary ultrasound systems proves to be rather problematic. Conventional high-end systems are designed to be mobile; in reality, however, because such systems typically weigh more than 100 kg, it is difficult to transport them, and these units should be handled with extreme care. This limits ultrasonographic examination to the echo laboratory, which necessitates additional staff and time to transport patients, which may not be beneficial for their condition. Furthermore, the number of high-end systems available is constrained by the average device cost of $0.2–0.4 million. The advanced diagnostic capability is accompanied by a highly complicated user interface with an extremely steep learning curve when operated by novice echocardiographer. The problem of portability was, to a certain extent, solved by the

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introduction of laptop-sized hand-held echocardiographs, which enabled bedside examination. Although small, they cannot be described as a "carry everywhere" diagnostic tool. The technical progress in miniaturization has recently led to the clinical introduction of pocket-size imaging devices (PSIDs), which, because of their size and weight, can be routinely carried by physicians and used at point-of-care in various clinical scenarios (Sicari et al. 2011). They easily fit into pocket of a white lab coat and usually do not weigh more than 400 g, which may explain why they are described as visual stethoscopes, that is, a supplement to routine physical examination. Moreover, these PSIDs are simple to operate, potentially allowing their use by different types of medical professionals.

The aim of this study was to validate PSIDs as a screening tool for detection of access site complications after femoral artery puncture. We hypothesized that rapid ultrasonographic screening of artery puncture sites could facilitate early identification of access site vascular complications and enable immediate management.

METHODS

The study group consisted of 40 consecutive patients (26 men, 14 women; mean age: 69 ± 7 y) after percutaneous coronary intervention via the femoral approach. Twenty-eight patients underwent elective percutaneous interventions for exacerbation of chronic ischemic heart disease. Twelve procedures were performed for urgent indications (myocardial infarction with or without ST-segment elevation). At least one stent was implanted in each patient during the procedure. Twenty-six (65%) patients were overweight (body mass index [BMI] >25), and 11 (27.5%) patients were considered obese (BMI >30). Twenty-seven (67.5%) patients were diagnosed with arterial hypertension. Ten (25%) patients had a history of myocardial infarction.

Within 24 h after the femoral artery puncture, patients underwent bedside examination consisting of assessment of pain at the puncture site and the limb, palpation of the puncture site, auscultation and quick examination with a PSID. Signed informed consent was obtained from each patient. The study was approved by the ethics committee of our institution.

Pocket-size imaging device

The PSID used in this study was V-Scan Version 1.1 (GE Vingmed Ultrasound, Horten, Norway). The device features the non-interchangeable phased array probe G3 S (footprint: 13 × 19 mm) with a frequency range of 1.7–3.8 MHz, which is automatically adjusted. It enables 2-D gray-scale harmonic imaging as well color Doppler imaging. The image sector is limited to 75° for black and white imaging and 30° for color-overlay blood flow, at a maximum depth of 24 cm (Fig. 1).

Examination with the PSID was performed to search for abnormalities, with particular emphasis on assessment of blood flow in and around the femoral artery, around and distal to the puncture site, with the color Doppler technique. All examinations were performed using cardiac preset at an imaging sector depth of 6 cm (minimum possible sector depth in this PSID).

The conventional examination was performed in the echocardiographic examination room using a high-end stationary system (Vivid 7, GE Vingmed Ultrasound) with the GE Vivid 7 M12 L vascular linear probe (5.6–14.0 MHz). The imaging protocol was similar to that used during the PSID examination, but enriched with spectral pulsed or continuous wave Doppler at the discretion of the operator. Bedside examination was performed by a first-year cardiology resident; a control examination, using a high-end stationary system, was conducted by the same resident under the supervision of an experienced ultrasonographer.

Statistical analysis

Continuous and categorical variables are expressed as means ± standard deviations and percentages (%), respectively. κ statistics were used to determine concordance between bedside and regular examination findings.

RESULTS

A total of 40 patients (26 men, mean age: 69 ± 7 y) were included. Twenty-eight patients with chronic ischemic disease underwent elective percutaneous interventions, whereas 12 interventions were performed for urgent indications (acute coronary syndrome, 8 patients with acute myocardial infarction without ST-segment elevation, 4 patients with acute myocardial infarction with ST-segment elevation).

Physical examination suggested the presence of a pseudo-aneurysm in 4 patients. The mean duration of subsequent bedside PSID screening was 2.7 ± 0.7 min. In 3 of the 4 patients, PSID bedside examination revealed access site abnormalities, that is, a pathologic cavity with the existing blood flow in direct proximity of the artery. Scanning in search of communication between the cavity and artery was successful in two cases (Fig. 2). The presence of pseudo-aneurysms was confirmed during the full ultrasonographic examination in these 3 patients.

The fourth patient reported lower limb pain, paresthesia and puncture site tenderness on palpation; however, no pulsating groin mass was detectable on physical examination. The result of bedside puncture site screening proved to be normal, which was supported by the findings of the control examination, which did not reveal access site vascular complications.